

# NorthWestern Energy

## 2019 Electricity Supply Procurement Plan

For more information:

Online at: <http://www.northwesternenergy.com/2019-resource-plan>

Contact:

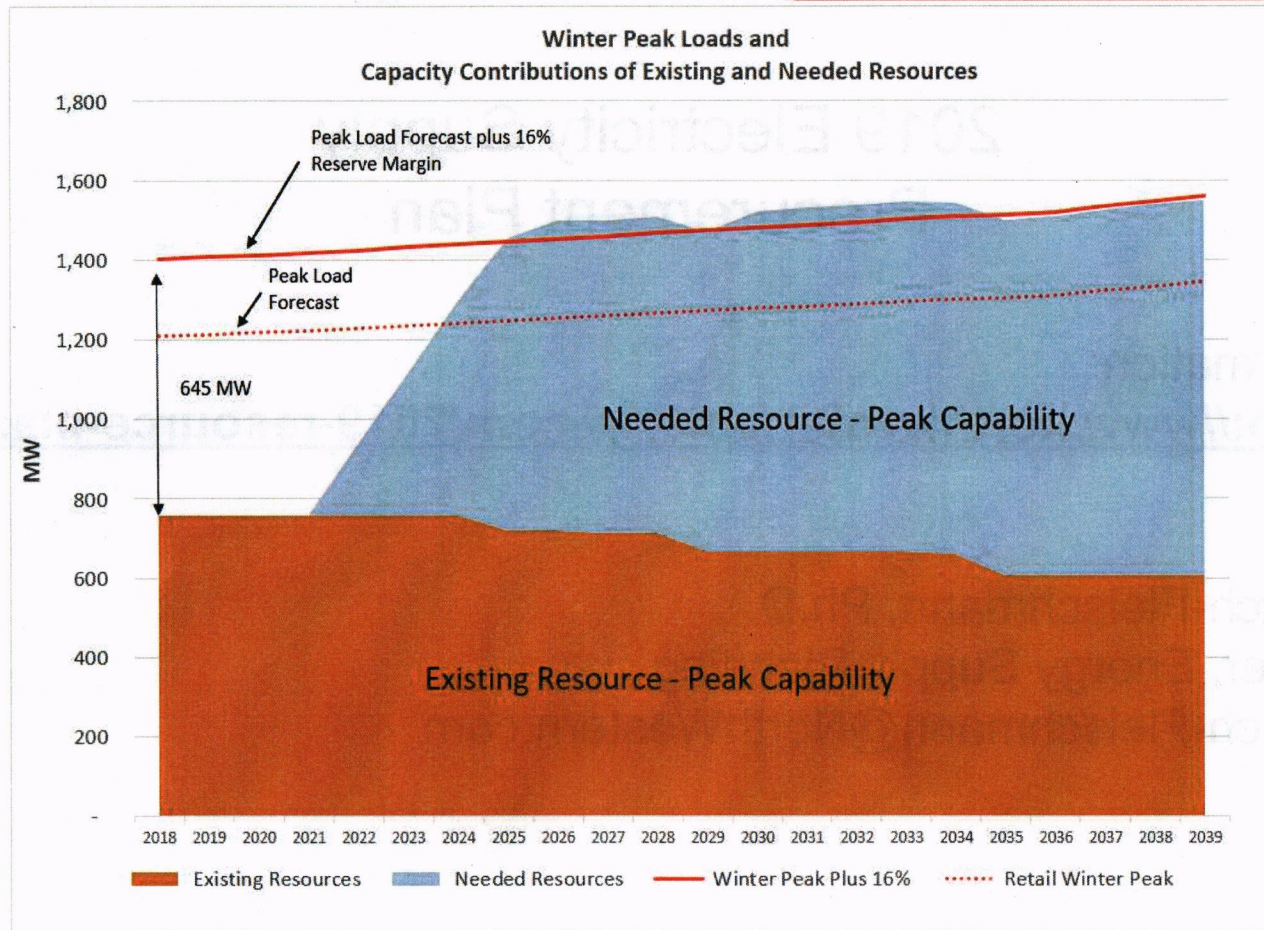
Ben Fitch-Fleischmann, Ph.D.

Manager, Energy Supply Planning

Ben.Fitch-Fleischmann@NorthWestern.com



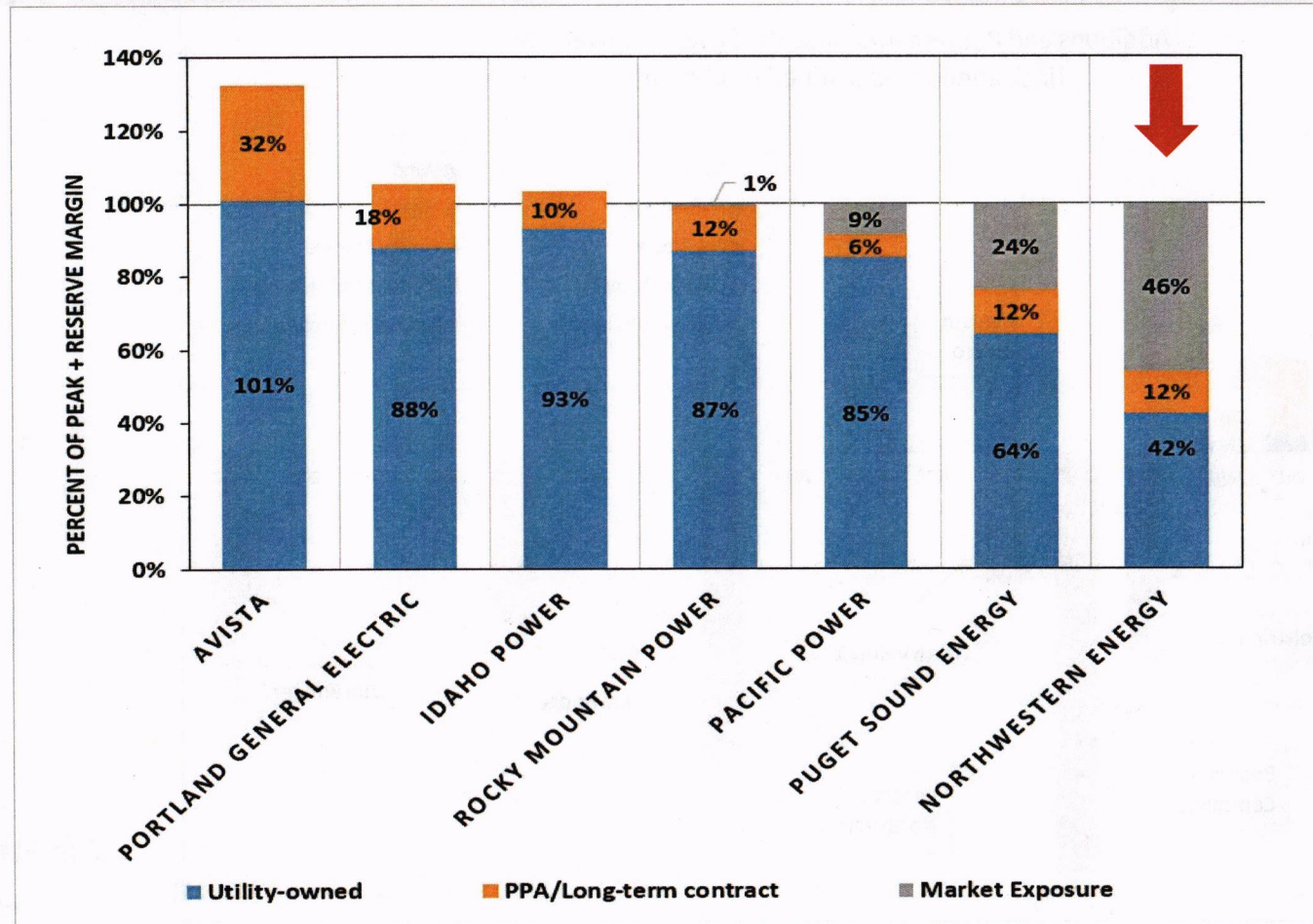
# NorthWestern Energy's Current Capacity Deficit





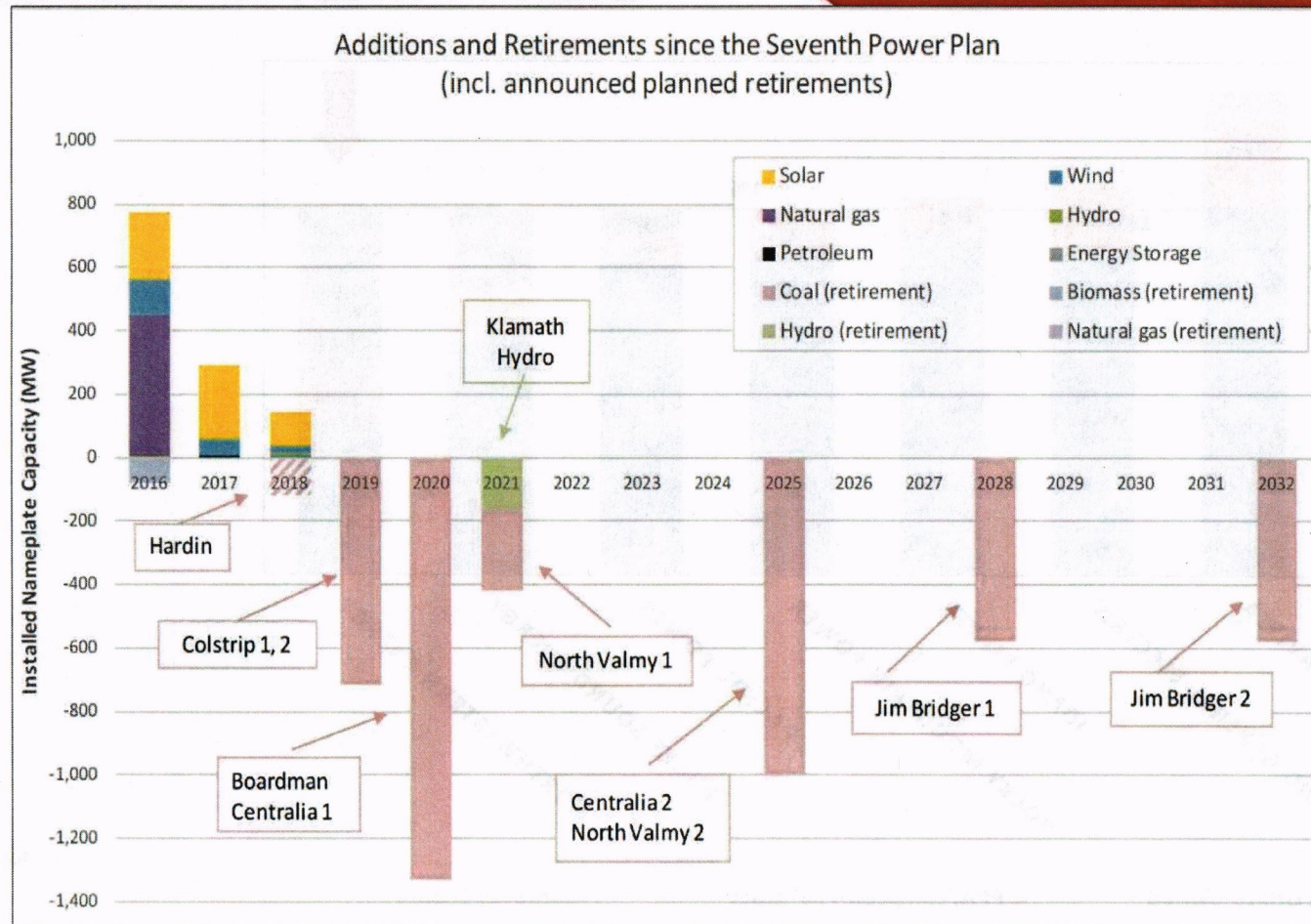


We rely heavily on the market.





# The market is changing.





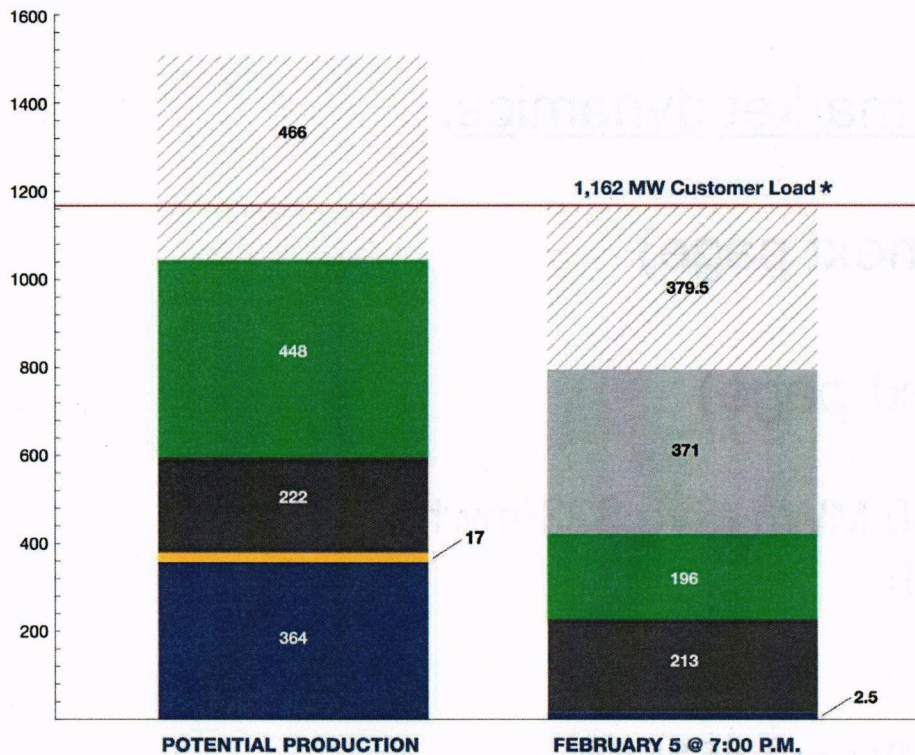


We are already seeing signs of new market dynamics.

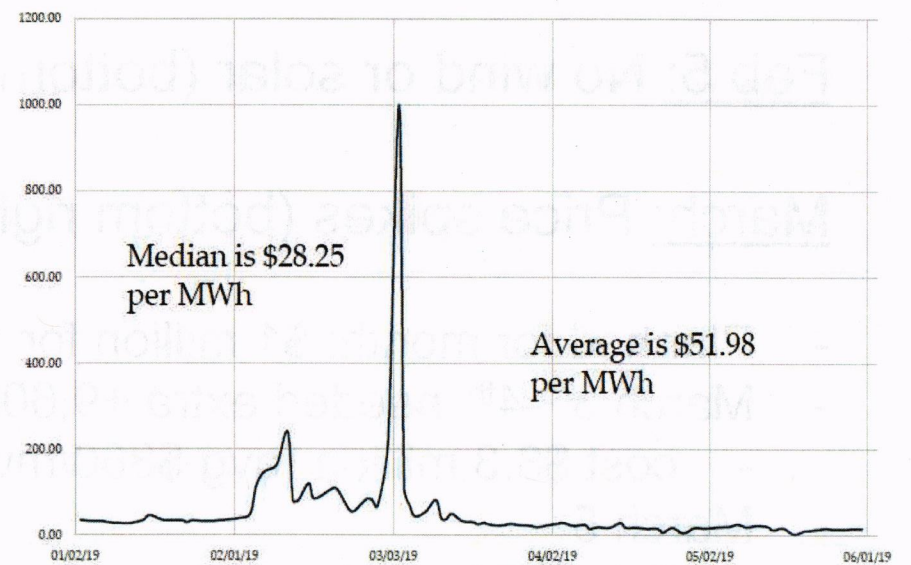
Feb 5: No wind or solar (bottom left next page)

March: Price spikes (bottom right next page)

- Planned for month: \$1 million for 43,200 MWh (avg \$23/mwh)
- March 3<sup>rd</sup>-4<sup>th</sup> needed extra +9,600 mwh
  - cost \$8.3 million (avg \$860/mwh)
- March 5
  - Total BPA wind <1% (less than 10 MW out of 2600+)



## Mid C Peak High Price

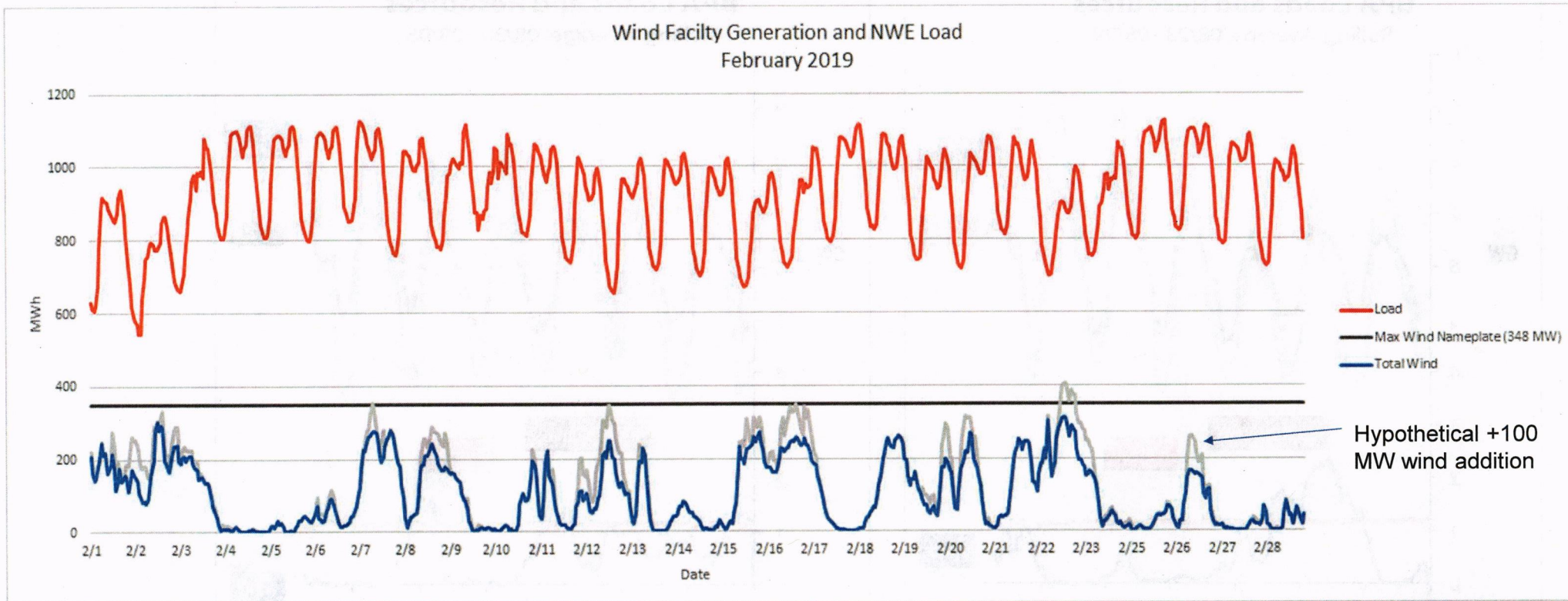


\*Doesn't account for large customer group load that additionally attributed to a peak electric demand.  
 \*\*While temperatures across Montana varied, it was -7 in Great Falls at the peak load hour.





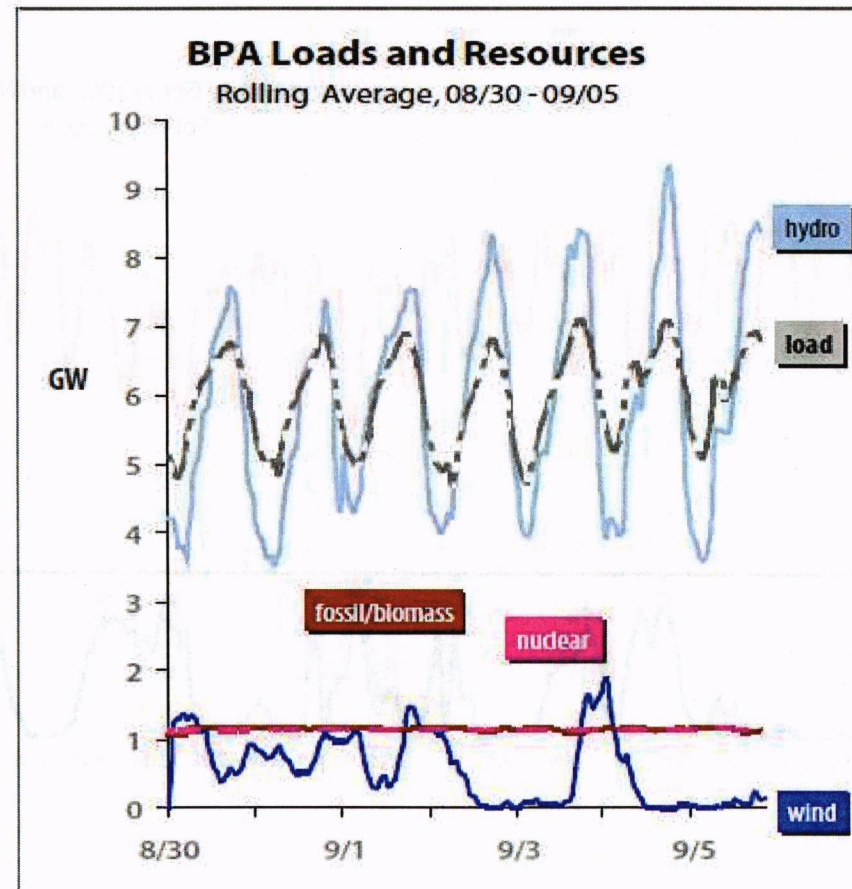
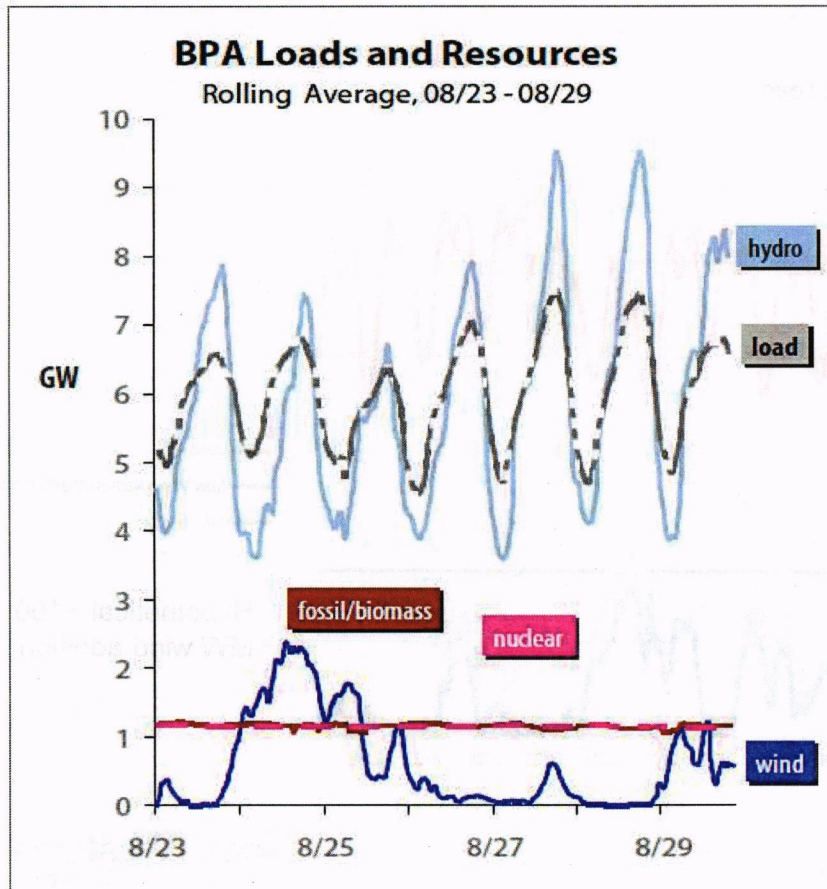
## Montana Wind - February 2019.





# Regional Generation

(Source: NewsData LLC)







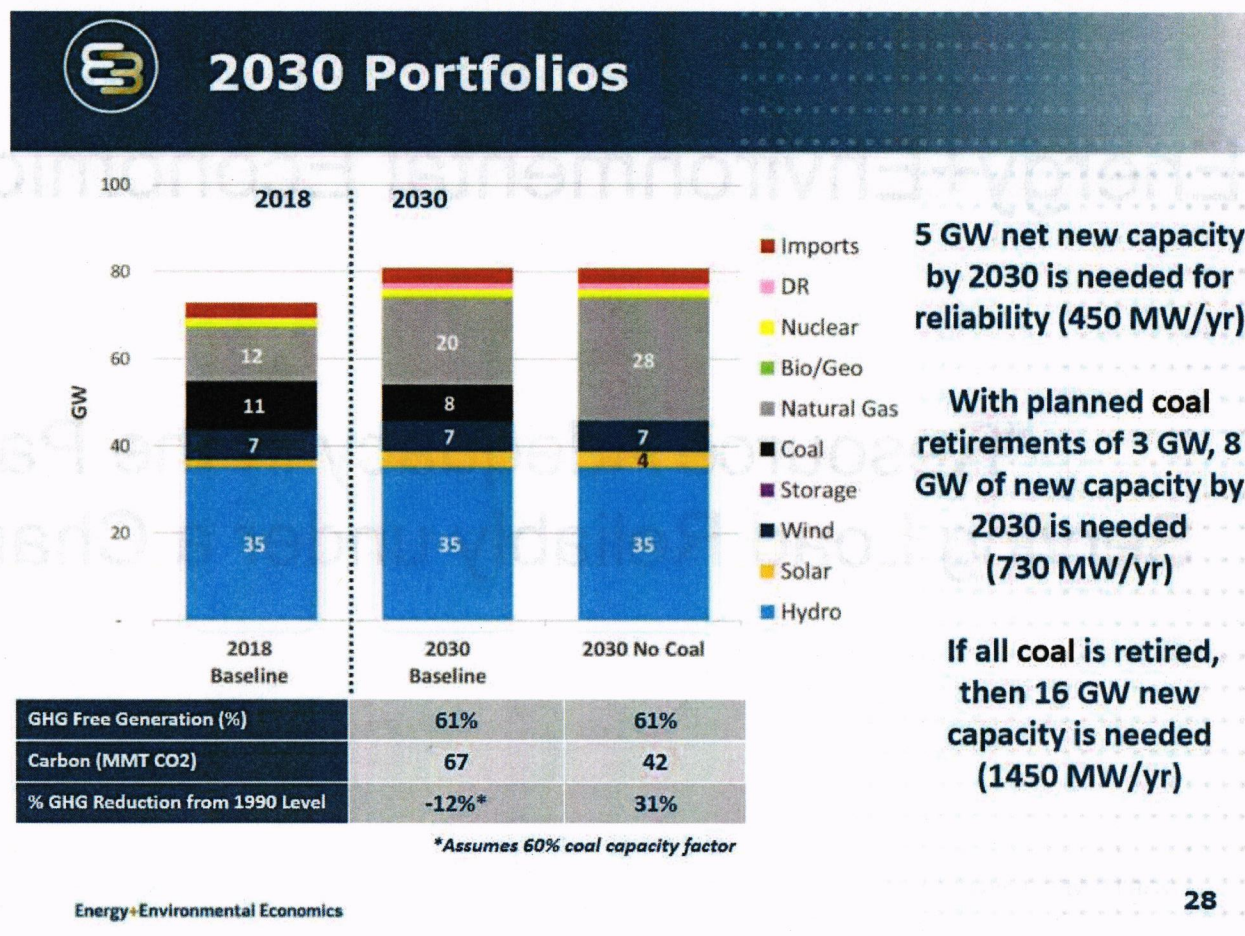
## Energy+Environmental Economics (E3) Study:

“Resource Adequacy in the Pacific Northwest:  
Serving Load Reliably under a Changing Resource Mix”



## E3 Study of PNW Regional Reliability

48% chance of  
loss-of-load in 2030  
if no net increase  
in capacity.  
- E3 Study



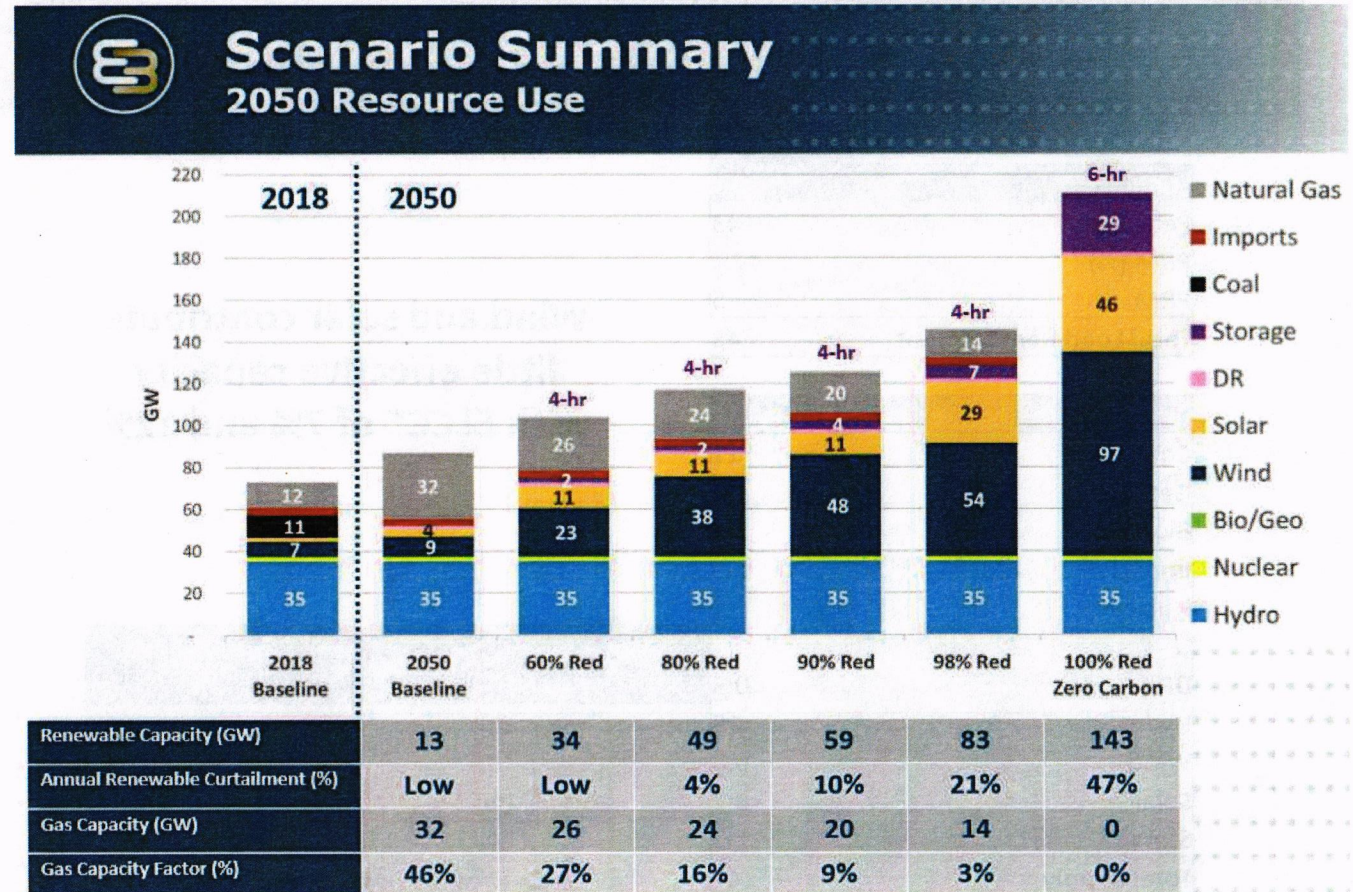




# E3 Study of PNW Regional Reliability

Even under aggressive carbon reductions, the region will need additional gas capacity for cost-effective reliability.

-E3







# E3 Study of PNW Regional Reliability



## 2018 Load and Resource Balance

2018	
Load (GW)	
Peak Load	43
PRM (%)	12%
PRM	5
Total Load Requirement	48

Resources / Effective Capacity (GW)	
Coal	11
Gas	12
Bio/Geo	1
Imports	3
Nuclear	1
DR	0.3
Hydro	18
Wind	0.5
Solar	0.2
Storage	0
Total Supply	47

Wind and solar contribute little effective capacity with ELCC\* of 7% and 12%



Nameplate Capacity (GW)	ELCC* (%)	Capacity Factor (%)
35	53%	44%
7.1	7%	26%
1.6	12%	27%

\*ELCC = Effective Load Carrying Capability = firm contribution to system peak load

Even accounting for regional diversity, the capacity contribution of wind and solar is limited.

–E3





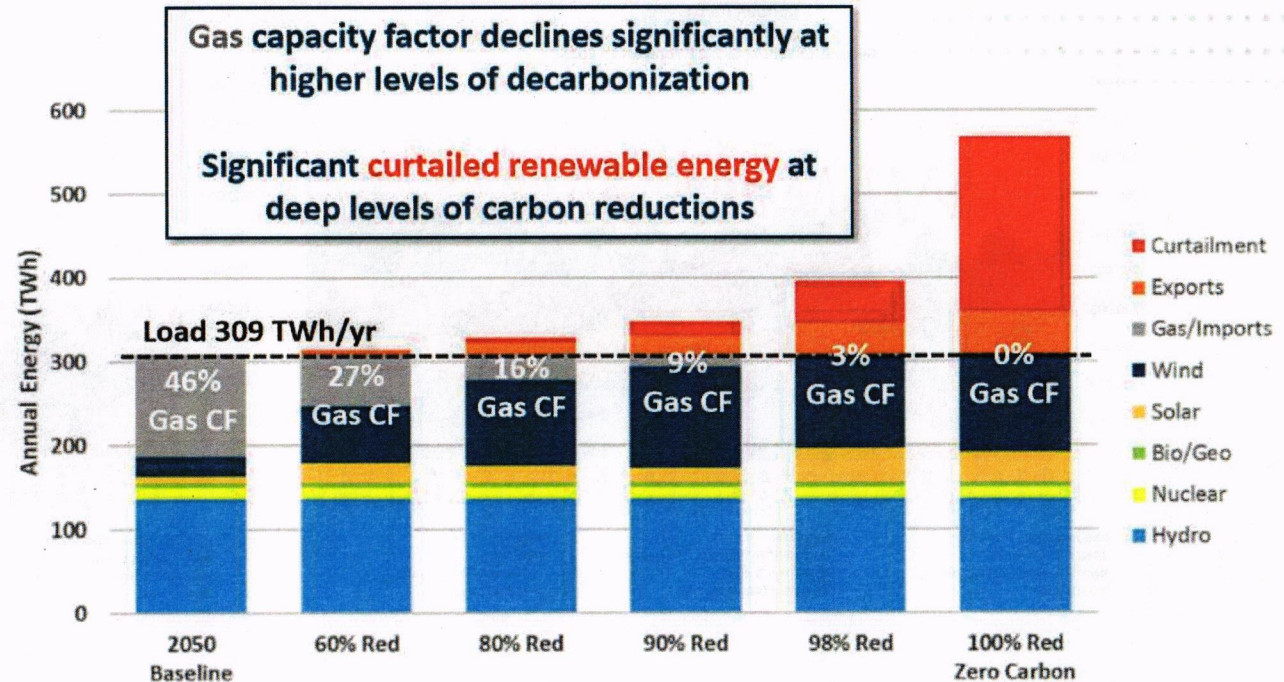
# E3 Study of PNW Regional Reliability

High renewables  
may require  
curtailments.

-E3

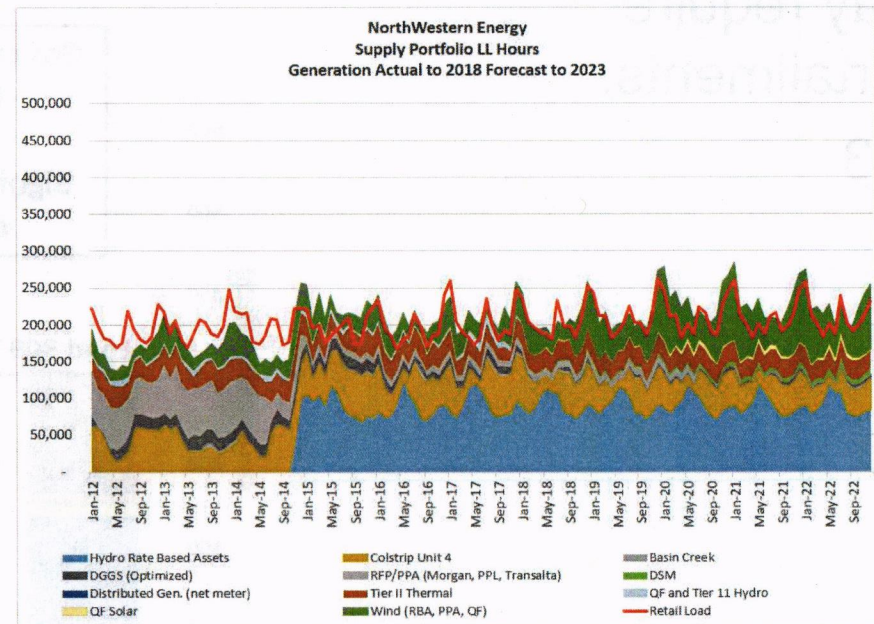
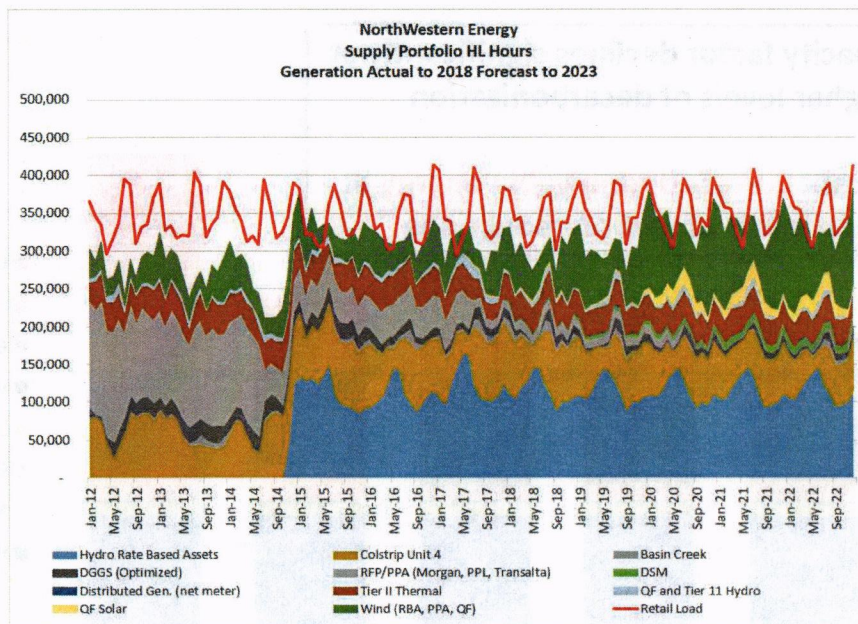


## 2050 Annual Energy Balance



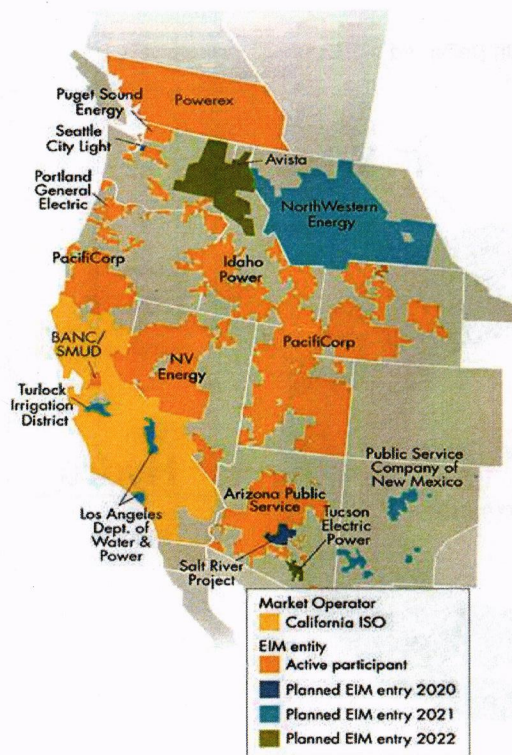


At times, NorthWestern currently has excess energy from renewables, which it sells to the Mid-C market.





# We are joining the Energy Imbalance Market



## Active Participants

- PacifiCorp, 2014
- NV Energy, 2015
- Puget Sound Energy, 2016
- Arizona Public Service, 2016
- Portland General Electric, 2017
- Idaho Power, 2018
- Powerex, 2018
- BANC/SMUD, 2019

## Pending Participants

- Salt River Project, 2020
- Seattle City Light, 2020
- Public Service of NM, 2021
- NorthWestern Energy, 2021
- Avista, 2022
- LADWP, 2021
- Tulock Irrigation Dist, 2021
- Tucson Electric, 2022

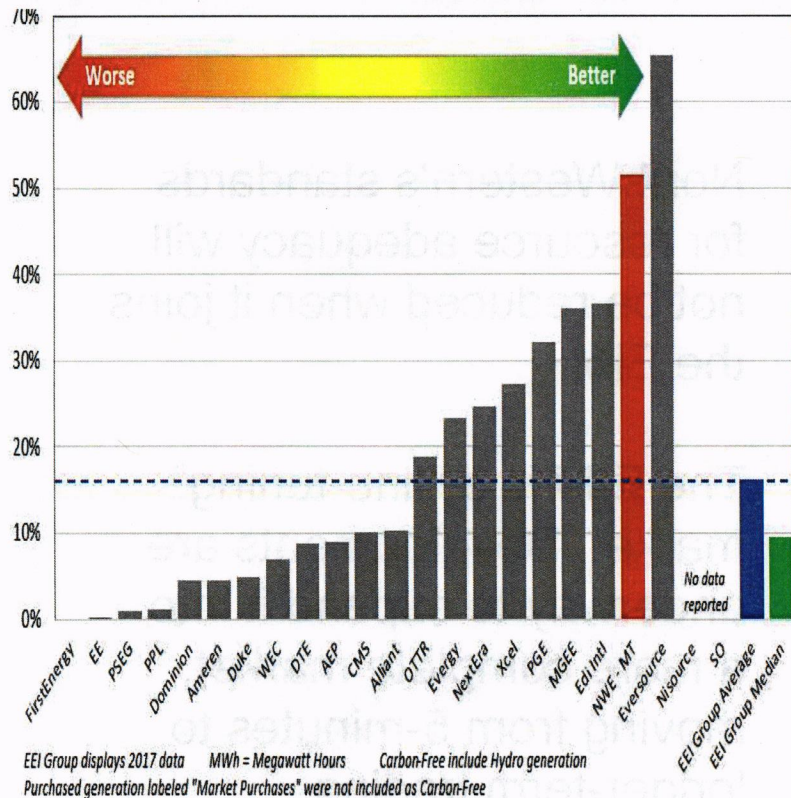
NorthWestern's standards for resource adequacy will not be reduced when it joins the EIM.

The EIM is a "fine-tuning" market. Developments are underway to expand it into a more complete market, moving from 5-minutes to longer-term trading.

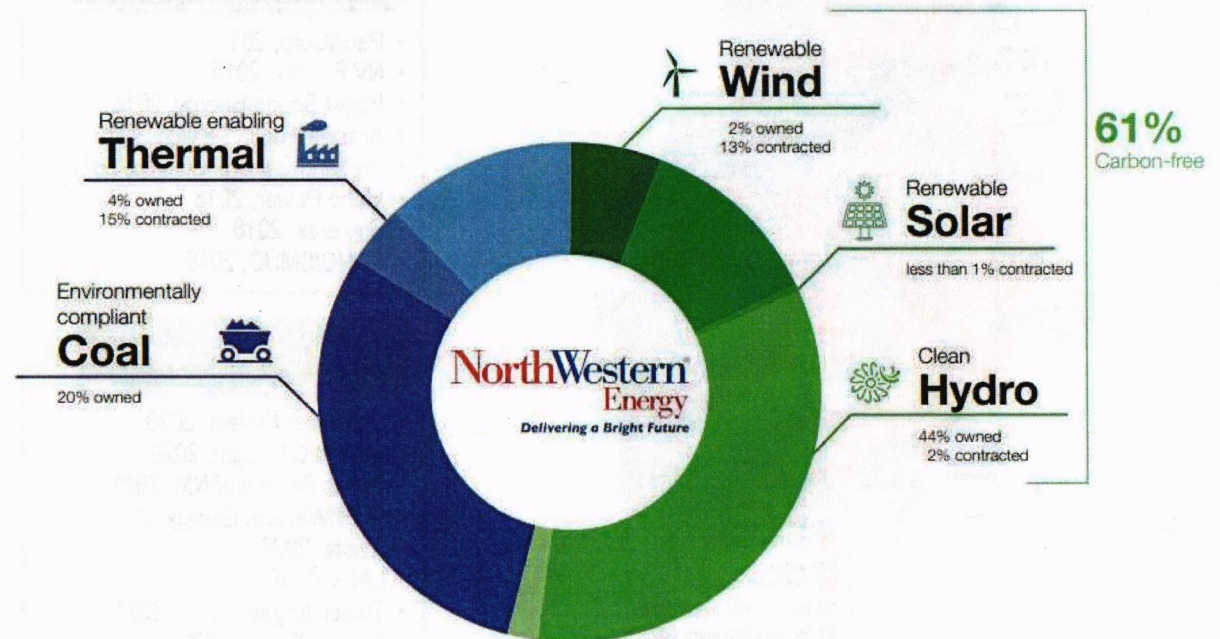




# NorthWestern's Current Portfolio



Based on 2018 MWh Delivered



**NorthWestern Energy**  
Delivering a Bright Future





# 2019 Plan – Portfolio Modeling

Western Montana (\$2018)	Fuel	Nameplate Capacity (Nominal)	Design Life	Net Output - Winter	Net Heat Rate Winter (HHV) <sup>1</sup>	Capital Cost <sup>2</sup>	Fixed O&M (Yr 1)	Variable O&M (Yr 1)
Technology	(Type)	(MW)	(Years)	(MW)	(Btu/kWh)	(\$/kW)	(\$/kW-yr)	(\$/MWh)
<b>Combustion Turbine - Dry Cooling</b>								
Simple Cycle 1x0 CT - 50 MW Frame	NG	48.1	30	45.8	9,986	\$1,433	\$13.18	\$8.73
Simple Cycle 1x0 CT - 25 MW Aeroderivative	NG	28.1	30	26.7	9,902	\$1,659	\$20.42	\$5.58
Simple Cycle 1x0 CT - 50 MW Aeroderivative	NG	47.4	30	45.2	9,388	\$1,336	\$13.38	\$4.38
Combined Cycle 2x1 CT - Frame/Industrial CT	NG	133.3	30	127.0	7,210	\$1,323	\$25.75	\$6.30
<b>Reciprocating Internal Combustion Engine</b>								
DGGS Buildout 3x0 RICE - 18 MW Class NG Only	NG	3x19.4	30	50.0	8,503	\$1,482	\$10.29	\$6.57
Simple Cycle 1x0 RICE - 18 MW Class NG Only	NG	19.4	30	18.5	8,329	\$1,833	\$23.26	\$4.68
Simple Cycle 1x0 RICE - 9 MW Class NG Only Western	NG	9.5	30	9.2	8,103	\$2,324	\$54.62	\$4.55
<b>Wind Energy</b>								
Wind Energy	N/A	105.0	25	100.0	N/A	\$1,410	\$37.00	N/A
<b>Solar Photovoltaic (PV)</b>								
Solar PV - Single Axis Tracking	N/A	105.0	20	100.0	N/A	\$1,330	\$21.60	N/A
<b>Geothermal</b>								
Geothermal - Flash Steam	N/A	21.0	30	20.0	1,000	\$2,800	\$123.98	\$9.88
<b>Pumped Hydro Energy Storage (PHES)</b>								
PHES - Closed Loop (9 Hour)	Elec. Grid	325.0	30	300.0	N/A	\$1,700-\$3,000	\$14.55	\$0.90
<b>Compressed Air Energy Storage (CAES)</b>								
CAES - Diabatic (8 Hour)	Elec. Grid / NG	105.0	30	100.0	4,500	\$1,500-\$2,300	\$15.27	\$8.53
<b>Battery Energy Storage System (BESS)</b>								
BESS - Lithium Ion (4 Hour)	N/A	26.3	20	25.0	N/A	\$1,660	\$39.61	\$7.00
BESS - Vanadium Flow (4 Hour)	N/A	26.3	20	25.0	N/A	\$1,700	\$34.01	N/A

<sup>1</sup> Thermal heat rates are presented on a higher heating value (HHV) basis.

<sup>2</sup> \$/kW capital cost metrics divide estimated project costs by the net winter output for a given technology.

<sup>3</sup> Capacity factors for dispatchable technologies assumed in order to develop O&M costs.

<sup>4</sup> Dual fuel performance and costs are presented as a blend of NG and alternative fuel (NG or FO) operations (1,034 hours on NG and 263 hours on alternate fuel)





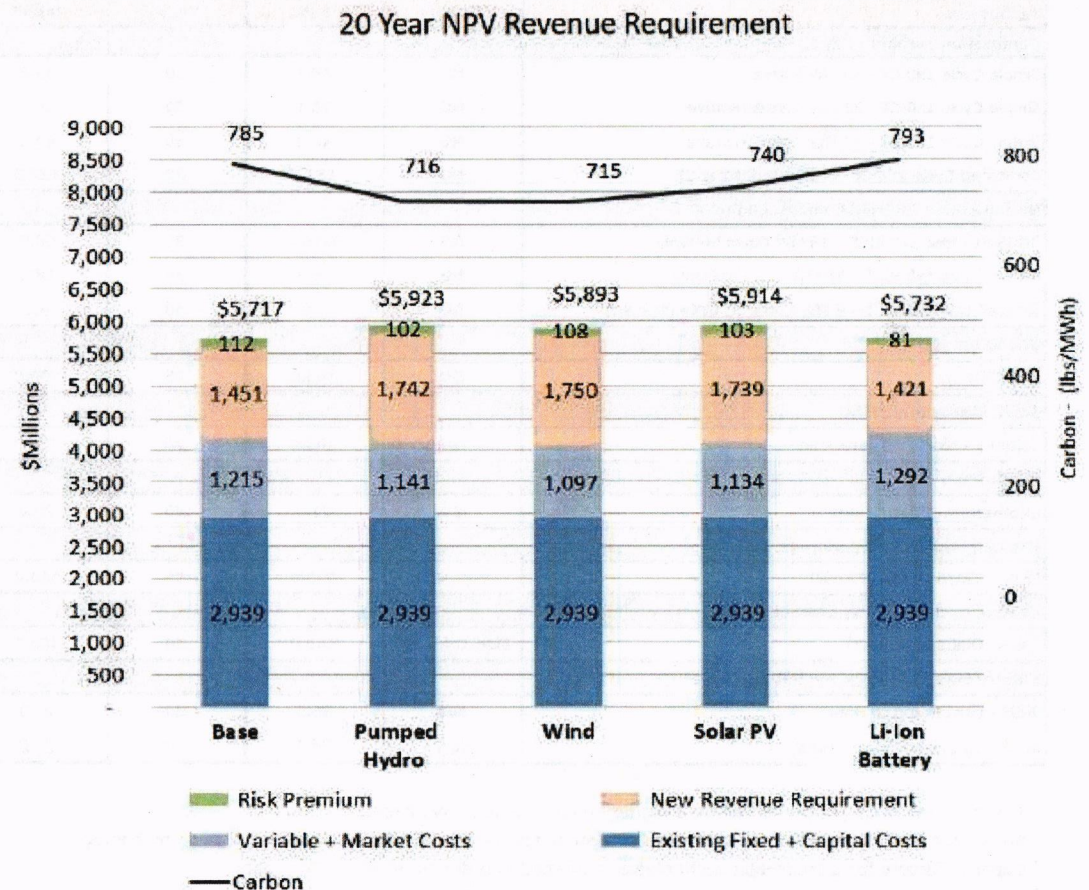
## 2019 Plan – Portfolio Modeling

Portfolios included:

- Pumped Hydro Storage, Batteries, Wind, Solar, Natural Gas, “No new carbon” portfolio

Based on simulations of:

- Weather, loads, hydro, renewable generation, electricity and gas prices (including potential high carbon prices, potential high natural gas prices)







## Next Steps: Solicit Proposals for Capacity Resources

### Issue Request for Proposals (RFP)

- Participation and oversight by MPSC, MCC
- All technology types eligible (including storage, renewables, demand response, natural gas, etc)
- Select the resource(s) that are cost-effective and provide greatest benefits to customers (standard is least cost and least risk)
- Key: The 2019 Plan is informational, resource selection occurs in RFP



# **2019 Electricity Supply Resource Procurement Plan**

PLAN SUMMARY

AUGUST 2019

**NorthWestern<sup>®</sup>  
Energy**

*Delivering a Bright Future*



Montana's energy landscape is evolving, changing from a state that produces more electricity than our citizens can use 24x7, 365 days a year, to a state where there is a growing risk there won't be enough electricity to serve our citizens at critical times of peak load. A similar situation is occurring throughout the Pacific Northwest – a key source for NorthWestern's market purchases. The NorthWestern Energy Electricity Supply Resource Procurement Plan addresses this critical risk and outlines how the company's Montana customers' energy needs will be met with reliable energy at the lowest cost.



Reductions in regional and in-state coal generation are limiting the ability of Montana to import and export energy, and growth in customer energy demand across the Pacific Northwest means the energy available from the market will be less certain at key times and prices will be more volatile. NorthWestern Energy has been reducing our customers' exposure to the market by developing a portfolio that includes hydro, natural gas, coal, wind, and solar generation. However, in order to manage the increasing risk to our customers and continue providing them with reliable energy, NorthWestern Energy must work quickly to reduce our customers' exposure to power markets, especially for certain types of power products.

In early March 2019, Mid-C peak bulk power prices reached nearly \$1,000/MWh for the first time since 2000 and natural gas also traded at record high prices. While the region was experiencing extreme weather, analysis indicates that decreased market liquidity was also a significant factor. NorthWestern is concerned events like this may become more frequent and is taking steps to mitigate current wholesale market exposure. Continuing to assume the market will always be able to provide customers with sufficient electricity at affordable prices is a reckless approach that could have severe reliability and cost consequences.



*Transmission lines are centered around the Colstrip Power Plant.*





*In NorthWestern Energy's Billings division there are 23 out of the company's 57 largest customers that demand over 1MW of energy, including a variety of large commercial and industrial customers.*

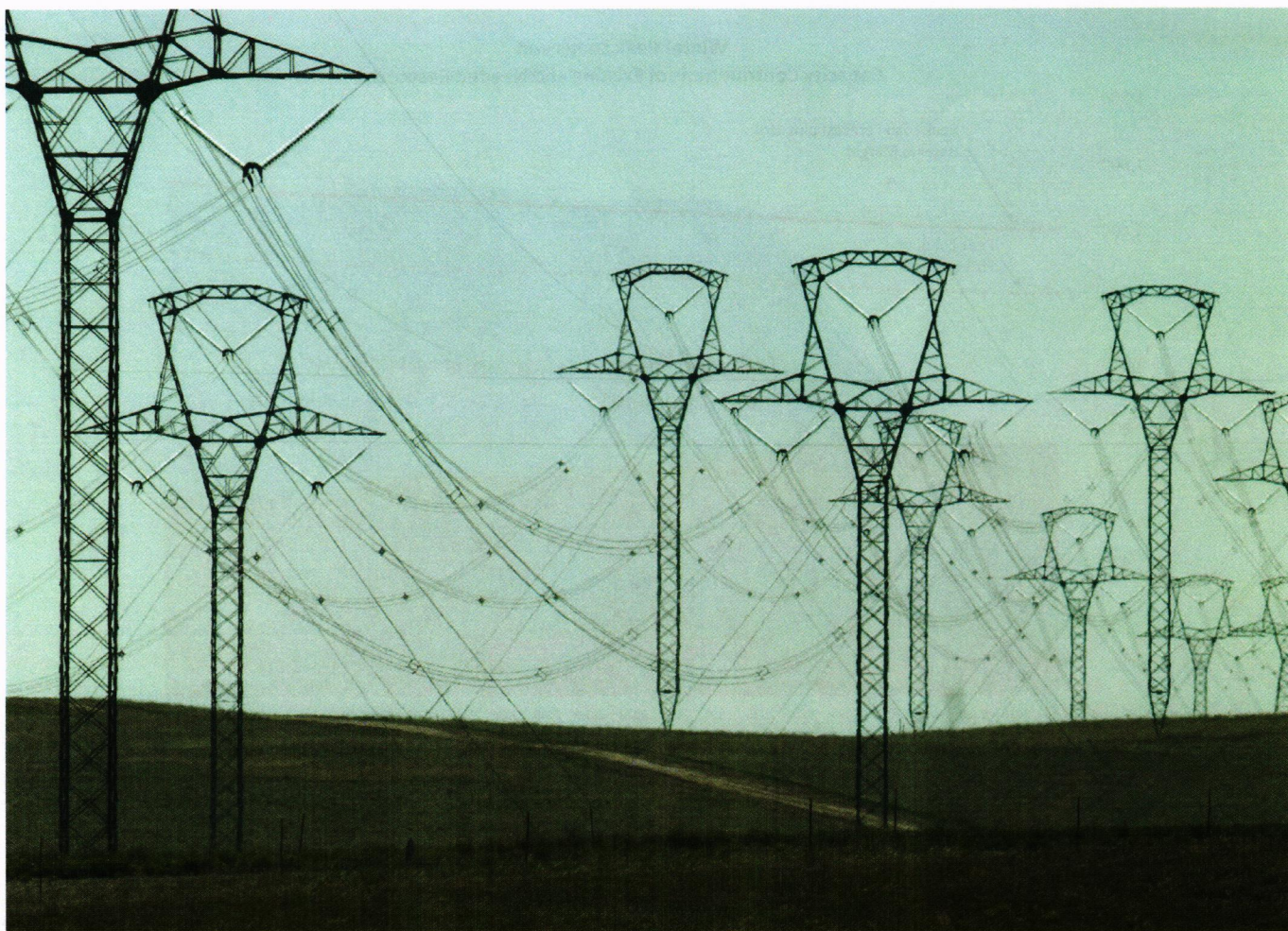
## OUR CUSTOMERS' MAJOR RISK IS NOT HAVING SUFFICIENT ENERGY WHEN THEY NEED IT MOST.

---

- NorthWestern Energy's current peak requirement (the amount of electricity needed to service all customers at the times of highest demand plus a planning reserve margin) is about 1,400 megawatts (MW). This is 645 MW more than the peak capability of NorthWestern's current portfolio.
- Planned regional retirement of 3,600 MW of coal-fired generation will cause regional peak energy shortages as early as 2021.
- Due to planned Montana coal generation retirements (and potential unplanned retirements), critical transmission capacity and access to other states' power markets will be limited.



- NorthWestern is planning to join the Western Energy Imbalance Market (EIM) in 2021 which will bring many benefits to our customers. However, this will require NorthWestern to control sufficient supply to meet hourly loads – including peak loads.
- Regional discussions are currently underway to build upon the EIM and develop a more fully organized market which will require NorthWestern to control the full amount of peak energy to serve demand, plus a reserve margin.



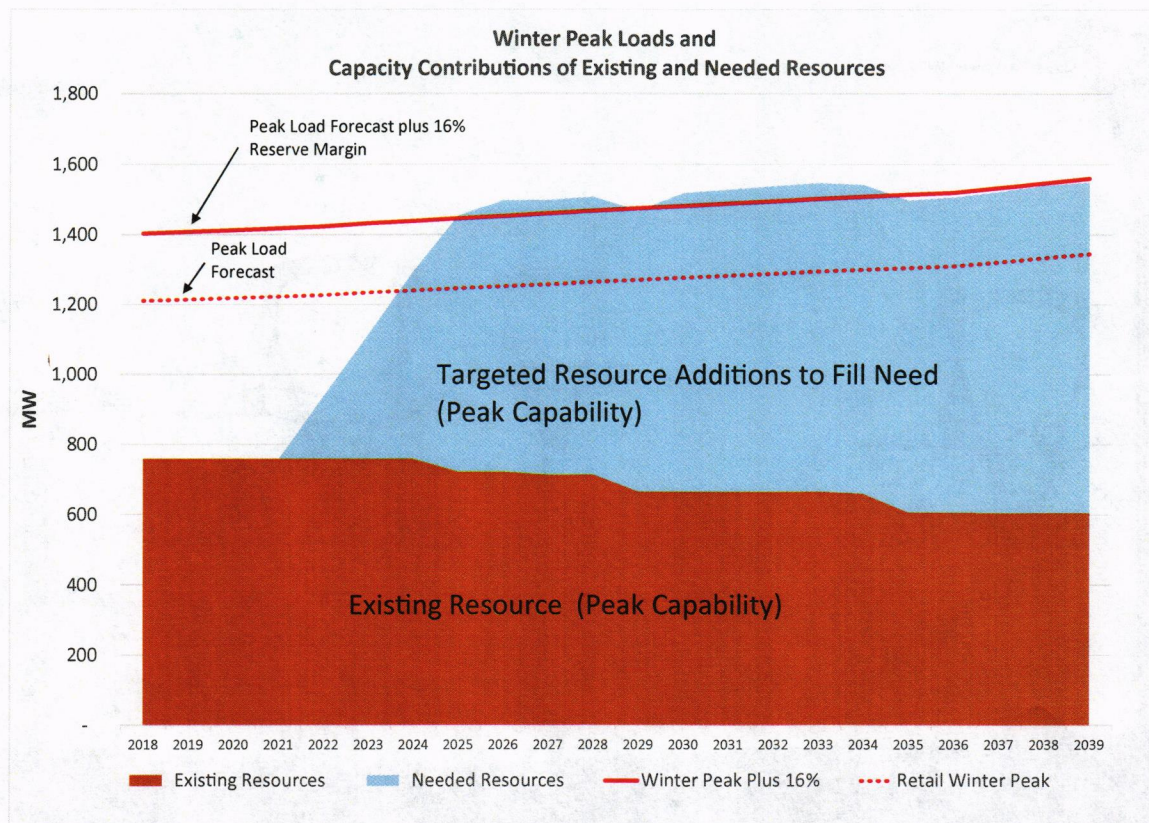
The Colstrip Transmission System was designed to primarily export energy, but it is also used to import energy from out-of-state sources, especially during critical times. Due to its designed purpose, under many circumstances the Colstrip Transmission System may not be adequate to import energy from markets outside of Montana to replace the power used in Montana that is generated now at the Colstrip units.



# PLANNING FOR THE FUTURE

## CAPACITY NEEDS

NorthWestern Energy's current resources provide about 755 MW of peaking capacity, which is the energy available during periods of our customers' highest demand. An additional 645 MW of peaking capacity must currently be purchased from the market to meet our needs. Without new peaking capacity, the market exposure will increase to about 725 MW by 2025 (including reserve margins). This peaking need assumes continued development of cost-effective demand side management (conservation) and small distributed generators (net-metering). Meeting peak load with market purchases means being exposed to the market at the worst possible time – when the market is volatile and prices are high.



## FLEXIBLE CAPACITY NEEDS

NorthWestern's customers need resources capable of providing more than just energy and peaking capacity. NorthWestern's resource portfolio generally generates enough energy to serve average load, but is significantly short both peaking and flexible capacity. Resources that can be dispatched on-demand to ramp up or shut down relatively quickly are identified as flexible capacity. Flexible capacity is needed to match generation to short-term variations in load. Additionally, variable energy resources like wind and solar require dispatchable energy resources to balance the energy grid and assure reliability. NorthWestern Energy's current levels of flexible capacity resources are adequate for the existing resource portfolio, but will fall short following the current planned (and future unplanned) additions of wind and solar resources. (Unplanned additions come mainly through "Qualifying Facilities" that our customers are required to purchase by law.)

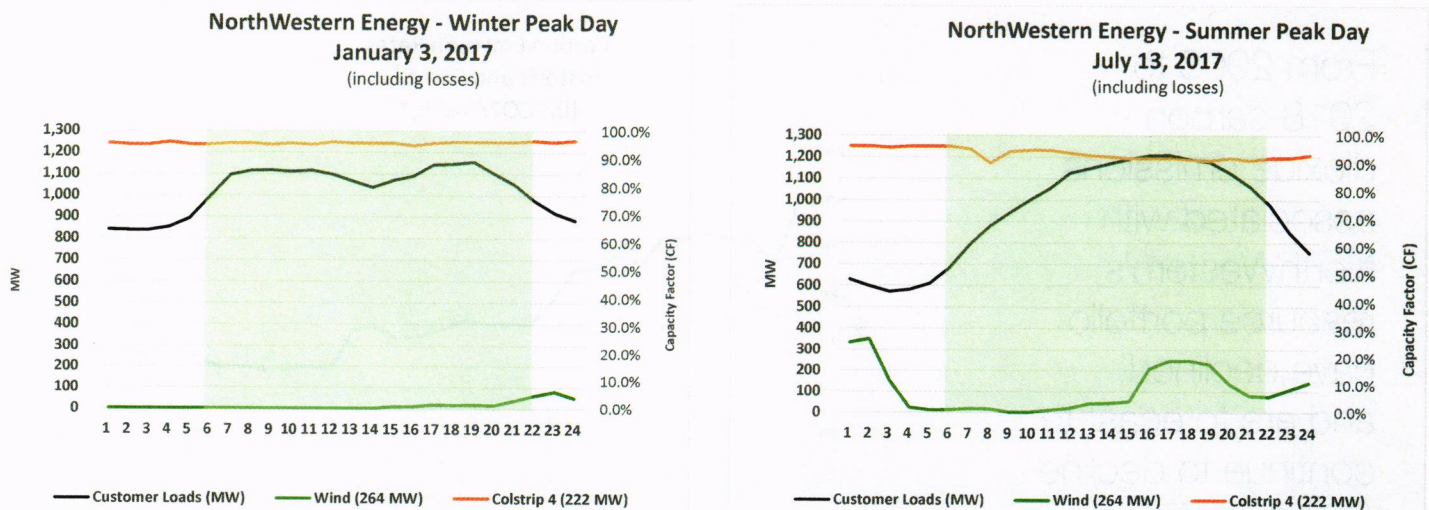


NorthWestern Energy's customers require the most energy during times of extreme hot or extreme cold temperatures. Fast, dispatchable generation resources are needed to provide reliable service to our customers during these times of high demand. Wind generation is low during these periods due to the low or nonexistent winds associated with high pressure systems accompanying temperature extremes. Solar generation contributes to summer peak loads but provides no significant contribution to address winter peak loads, which occur after sunset.

## ENERGY NEEDS

While NorthWestern Energy has an immediate need for resources during periods of highest demand, our current portfolio is much better off when looking at customers' average energy needs. The type of products generation resources can produce is critical to ensure the specific needs of the portfolio are met without having to acquire excess generation. During heavy load hours, the current resource portfolio produces a little less energy (on a monthly basis) than customers consume. During light load hours, the portfolio produces more energy (on a monthly basis) than customers consume. Excess energy is sold into the wholesale electricity market at lower prices, often lower than the cost of the energy being produced. This is done because NorthWestern must take the energy from variable resources like wind even if it is not needed, and the hydro and thermal resources like Colstrip have minimum production levels or must be operating in order to respond to changes in wind generation or loads.

Wind and solar are capable of providing low-cost energy but are generally not available when customers need it most, such as after sunset on the coldest winter days in December and January. The Winter and Summer peak load days of 2017 (January 3rd and July 13th) are shown in Figure 1-2 below. The black line represents customer load - shown as MW on the left hand scale. The dashed green line shows wind production as percentage of its nameplate capacity on the right hand scale. The orange line represents Colstrip 4 production, also shown as a percentage of its nameplate capacity on the right hand scale. NorthWestern has seen this pattern repeatedly since 2017, most recently during a cold spell occurring the week of February 4th, 2019.

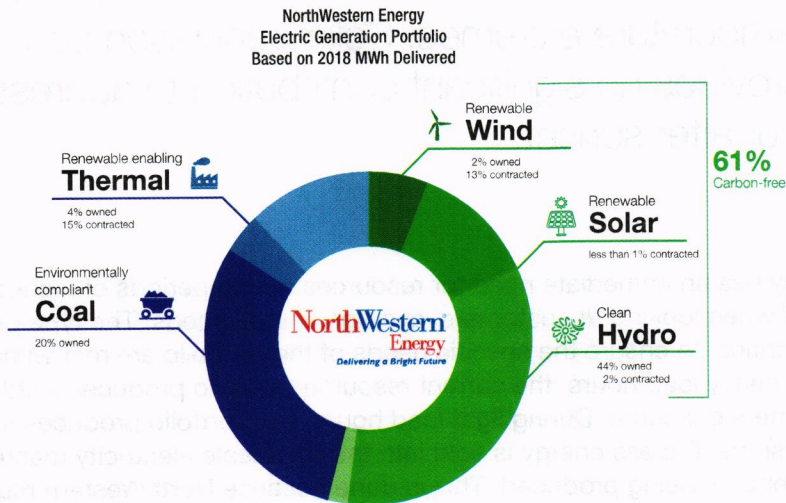


As illustrated above, wind contributed very little of its maximum generation capability (especially on the critical winter peak day), while Colstrip 4 generated at 90 to 95 percent of its maximum capability. During peak load periods, customers need resources that NorthWestern can call upon as needed, 24 hours a day, 7 days a week.



## CARBON EMISSIONS

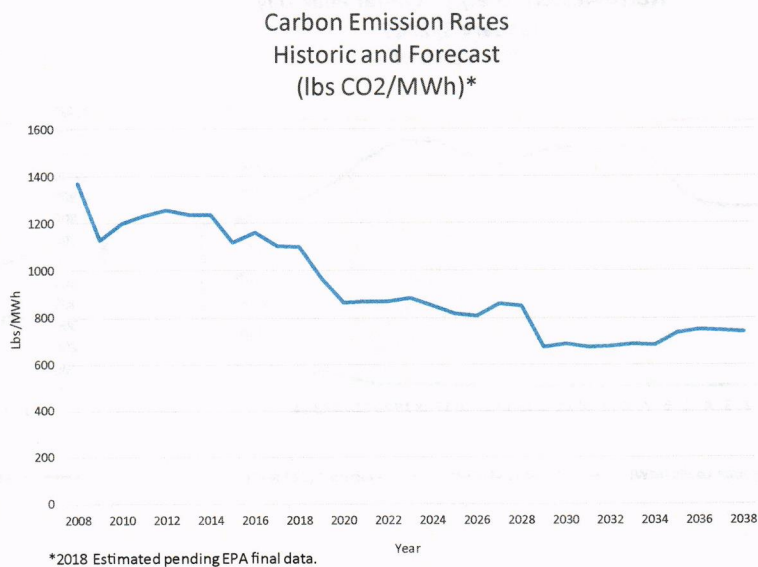
NorthWestern Energy purchased 11 hydroelectric facilities in 2014 with a current generating capacity of 448 MW (with potential for future upgrades). The hydroelectric system is primarily a run-of-the-river system which provides a large part of the backbone of our generation portfolio, contributes significantly to our low cost carbon-free energy production, and provides system reliability for our customers. In 2018 NorthWestern's energy portfolio produced 61% carbon free energy.



With the help of Montana's generation portfolio, NorthWestern continues to be one of the leaders in the industry for carbon free portfolios. Carbon dioxide emissions associated with NorthWestern's Montana portfolio have been significantly less than nearly all of our peer utilities.

From 2008 to 2018, carbon dioxide emissions associated with NorthWestern's resource portfolio have declined, and they are forecast to continue to decline. Resource opportunities, technology improvements, and technology cost reductions could also reduce emissions. As shown in Figure 1-4, carbon emissions associated with the Base portfolio decline over the term of the plan. Significant declines occur when Colstrip Energy Limited Partnership (CELP) and Yellowstone Energy Limited Partnership (YELP) leave the portfolio. Together, CELP and YELP provide about 11% of the energy in our portfolio but contribute about 35% of the carbon dioxide emissions.

From 2008 to 2018 carbon dioxide emissions associated with NorthWestern's resource portfolio have declined, and are forecast to continue to decline (Base portfolio shown above).



CELP is a 41.5 MW waste coal-fired Qualifying Facility with a contract that expires 6/30/2024.

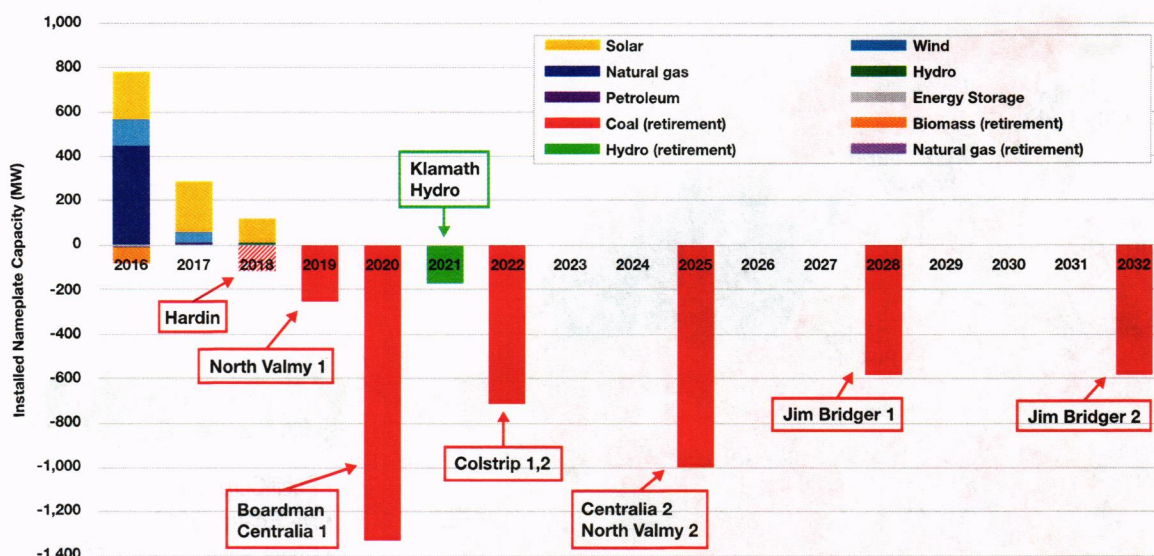
YELP is a 65 MW petroleum coke-fired Qualifying Facility with a contract that expires 12/31/2028.



# STATE AND REGIONAL COAL RETIREMENTS

Planned retirements in the Pacific Northwest region exceed 3,600 MW and the Northwest Power and Conservation Council forecasts regional capacity shortfalls as early as 2021. NorthWestern Energy's continued reliance on the market to purchase energy to fill the gap during peak customer demand will significantly increase price and reliability risk for NorthWestern Energy's customers because of the reduced energy supply availability. Future technological advances will help mitigate this risk, but NorthWestern Energy has an ongoing obligation to plan for affordable and reliable resources.

## PLANNED PLANT RETIREMENTS



Source: Northwest Power and Conservation Council. Note: Hardin is idle, but has not been retired.

## TRANSMISSION CONSTRAINTS



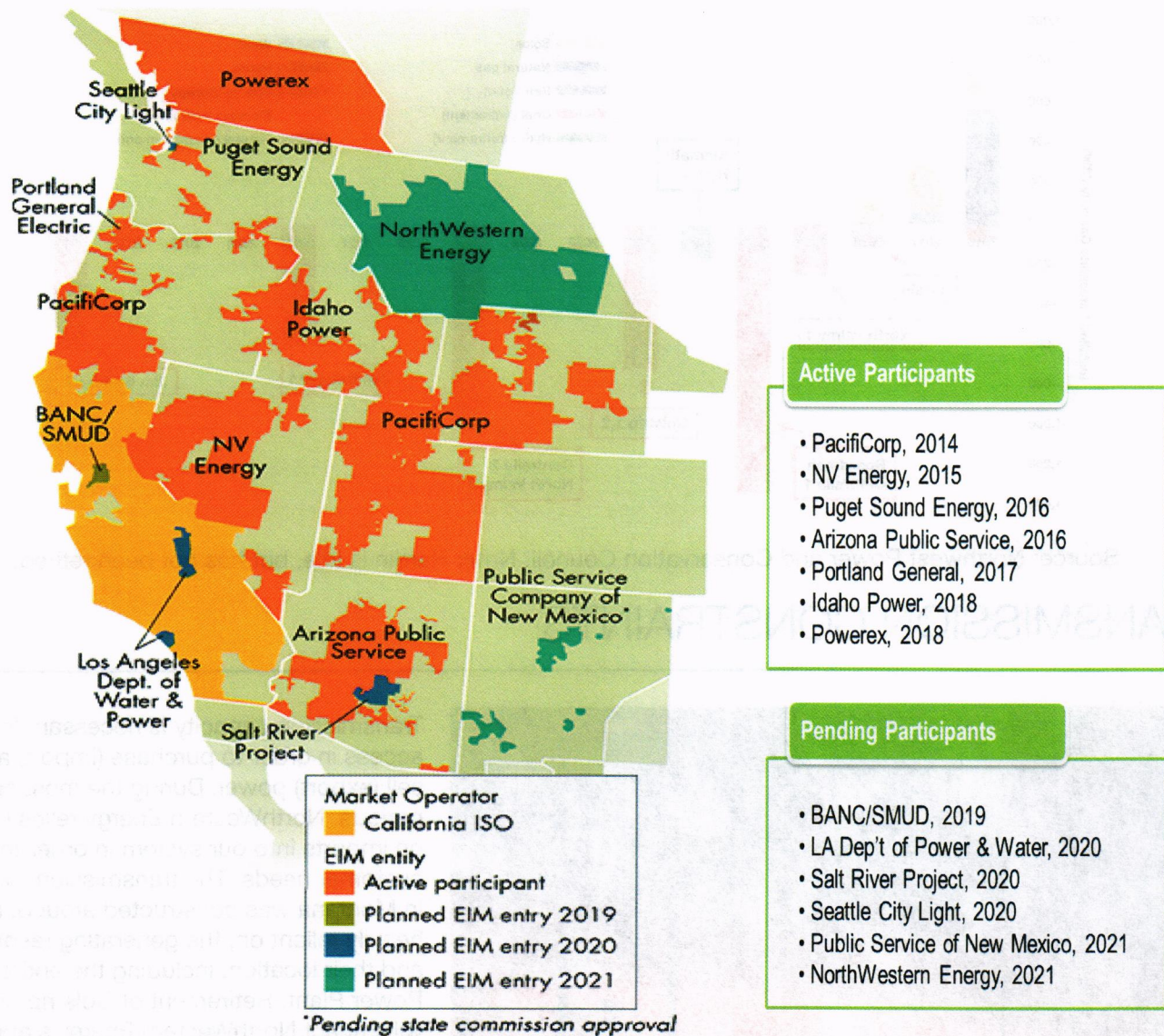
Transmission capacity is necessary for market access in order to purchase (import) and sell (export) power. During the most critical periods, NorthWestern Energy relies heavily on imports into our system in order to meet customer needs. The transmission system in Montana was constructed around, and is heavily reliant on, the generating resources and their location, including the entire Colstrip Power Plant. Retirement of Colstrip units will impact NorthWestern Energy's ability to import sufficient power to meet peak energy demand. As discussed earlier (page 1-3), the transmission lines at Colstrip are limited for the import of energy because they are designed to export energy. Another concern is that if no additional generation is built to justify keeping the current Colstrip transmission lines, those lines could also be retired, which will contribute to bottlenecks in the remaining energy transmission system used in Montana to serve NorthWestern Energy customers.



# INTEGRATING OUR GRID AND MARKETS

A significant event affecting NorthWestern's 2019 Resource Procurement Plan process was the decision by NorthWestern to join the EIM. On November 8, 2018, NorthWestern announced its intent to enter the Western EIM in the spring of 2021. With NorthWestern's execution of an Implementation Agreement, the total number of active and pending participants in the Western EIM now totals 14 utilities serving 80 percent of customer loads within the US portion of the WECC. Additionally, Bonneville Power Administration is currently undertaking a stakeholder process to consider EIM entry, and could join as early as 2022.

## WESTERN EIM ACTIVE AND PENDING PARTICIPANTS



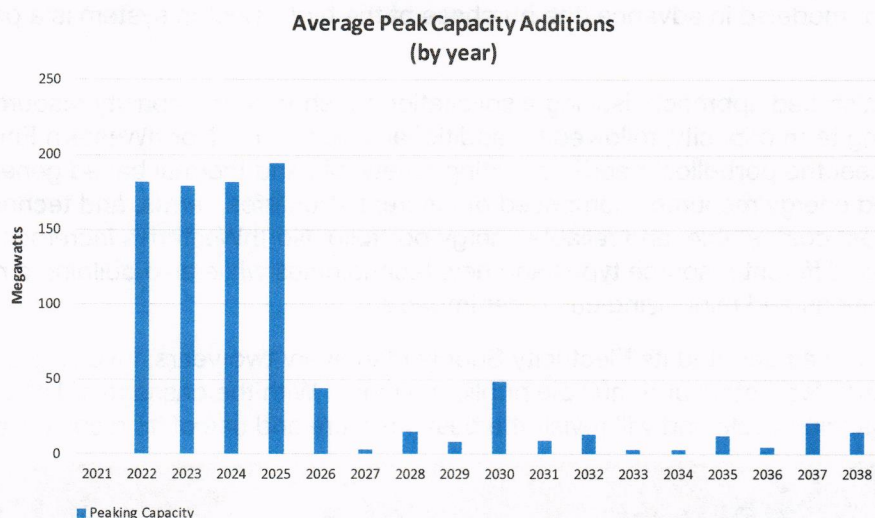
## REGIONAL TRANSMISSION ORGANIZATION (RTO)

In early 2018, the California Independent System Operator (ISO) began a process to enhance the day-ahead market within the full Independent System Operators footprint (the EDAM initiative). The enhancements to CAISO's day-ahead market are targeted to go live in 2019 with a platform that will allow the addition of a day-ahead market to the Western EIM. The extension of the day-ahead market to EIM participants, if supported by EIM members and CAISO, could go live as early as 2022. NorthWestern Energy assumes for the purposes of the 2019 Resource Procurement Plan that EIM entry will occur in 2021, and that a full RTO/ISO will develop by 2025.



## RESOURCE PORTFOLIOS

NorthWestern's resource plan shows the results of thirteen "future" resource portfolios. Each portfolio satisfies our peak capacity needs by adding resources that achieve resource adequacy by 2025 and maintain resource adequacy throughout the plan period. The graph below shows average peak capacity additions by year for all portfolios using automatic resource selection (ARS) to achieve a 16 percent reserve margin by 2025.



The portfolios identify resources with known costs and indicate that thermal resources provide the best value (lowest cost) to meet our customers' future needs for peak capacity. Renewable resources and energy storage technologies are projected to continue to decline in cost, but are still more expensive than natural gas fired resources, and were not selected by the model. A portfolio which meets our customers' future resource needs without the addition of any new carbon producing resources would lower carbon emissions, but at a cost. Meeting our customers' future needs by adding carbon free resources is projected to cost \$523,000,000 more than meeting their needs using natural gas fired resources. Moving to a 100% carbon free portfolio was not modeled, but a recent regional analysis indicates that it would be cost prohibitive.<sup>3</sup>

While our portfolio modeling shows that natural gas resources provide the lowest cost portfolio, competitive solicitations open to a wide variety of technologies will be used to determine which resources will ultimately serve our customers' needs as identified in this Plan at lowest cost.



The Basin Power Plant in Butte, Mont., is an example of a dispatchable peaking resource.

<sup>3</sup> Resource Adequacy in the Pacific Northwest study released March 2019 by Energy + Environmental Economics (E3).



# STRATEGY IN ACTION

---

In order to have adequate energy supplies to meet peak load requirements by 2025, NorthWestern Energy will solicit competitive proposals from a variety of resources and will also consider opportunity resource purchases. The model used to evaluate resources in this plan will also be used to evaluate resources submitted in competitive solicitations or opportunity resources. Opportunity resources consist of existing resources that become available for purchase and cannot be known or modeled in advance (the purchase of the hydroelectric system is a good example of an opportunity resource).

NorthWestern will use a staged approach, issuing a solicitation for short term capacity resources, an initial solicitation for up to 400 MW of long term capacity, followed by additional solicitations. NorthWestern Energy will evaluate all resources which can meet the portfolios' needs, including renewable and thermal based generation, power purchase agreements, and owned energy resources comprised of different structures, terms, and technologies with the long term objective of a lowest cost, stable, and reliable energy portfolio. NorthWestern's incremental approach will provide opportunities for different resource types and new technologies while also building a reliable portfolio to meet local and regional conditions and minimizing customer impacts.

In the past, NorthWestern has updated its Electricity Supply Plan every two years, involving a technical advisory committee with third party facilitators and multiple public meetings. With the passage of HB-597 NorthWestern will move to a three year planning cycle and will revisit the best structure and use of its technical advisory committee.



*The grid-connected Beck Hill Microgrid pilot project, located near Deer Lodge, Mont. uses an array of ground-mounted photovoltaic panels and inverters to generate electricity when conditions permit. Additionally, a battery bank allows this energy to be stored for use during outages and provide grid support during normal operations.*



NorthWestern Energy will consider all opportunity resources and solicit competitive proposals to meet customers' future energy resource needs. NorthWestern Energy will use an independent evaluator to conduct a proposal solicitation process open to all resources (including "demand side" resources) for up to 400 MW of peaking capacity, which is about one-quarter of NorthWestern Energy's projected need in 2025. The proposal solicitation process will consider a wide variety of resource options, resource sizing, ownership options and contract lengths.



**[NorthWesternEnergy.com](http://NorthWesternEnergy.com)**



